Continuous estimation of gross primary productivity and evapotranspiration from an Unmanned Aerial System

Wang, Sheng; Bandini, Filippo; Jakobsen, Jakob; Zarco Tejada, Pablo J.; Liu, Xin; Olesen, Daniel Haugård; Ibrom, Andreas; Bauer-Gottwein, Peter; Garcia, Monica

Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

Citation (APA):
Wang, S., Bandini, F., Jakobsen, J., Zarco Tejada, P. J., Liu, X., Olesen, D. H., Ibrom, A., Bauer-Gottwein, P., & Garcia, M. (2017). *Continuous estimation of gross primary productivity and evapotranspiration from an Unmanned Aerial System*. Abstract from 2017 AGU Fall Meeting, New Orleans, Louisiana, United States.

AGU FALL MEETING
New Orleans | 11–15 December 2017

Continuous estimation of gross primary productivity and evapotranspiration from an Unmanned Aerial System

Sheng Wang[1], Filippo Bandini[1], Jakob Jakobsen[2], Pablo J. Zarco-Tejada[3], Xin Liu[1], Daniel Haugård Olesen[2], Andreas Ibrom[1], Peter Bauer-Gottwein[1], Monica Garcia[1*]

1. Department of Environmental Engineering, Technical University of Denmark, 2800 Kgs. Lyngby, Denmark
2. National Space Institute, Technical University of Denmark, 2800 Kgs. Lyngby, Denmark
3. European Commission, Joint Research Centre, Directorate D - Sustainable Resources, Via E. Fermi 2749, 21027 Ispra (VA), Italy

Model prediction of gross primary productivity (GPP) and evapotranspiration (ET) using optical and thermal satellite imagery is biased towards clear-sky conditions. Unmanned Aerial Systems (UAS) can collect optical and thermal signals at unprecedented very high spatial resolution (< 1 meter) under sunny and cloudy weather conditions. However, methods to obtain model outputs between image acquisitions are still needed. This study uses UAS based optical and thermal observations to continuously estimate daily GPP and ET in a Danish willow forest for an entire growing season of 2016. A hexacopter equipped with multispectral and thermal infrared cameras and a real-time kinematic Global Navigation Satellite System was used. The Normalized Differential Vegetation Index (NDVI) and the Temperature vegetation dryness index (TVDI) were used as proxies for leaf area index and soil moisture conditions, respectively. To obtain continuously daily records between UAS acquisitions, UAS surface temperature was assimilated by the ensemble Kalman filter method into a prognostic land surface model (Noilhan and Planton, 1989), which relies on the force-restore method, to simulate the continuous land surface temperature. NDVI was interpolated into daily time steps by the cubic spline method. Using these continuous datasets, a joint GPP and ET model, which combines the Light Use Efficiency GPP model (Potter et al., 1993) and the Priestley–Taylor Jet Propulsion Laboratory ET model (Fisher et al., 2008; Garcia et al., 2013), was applied. The simulated GPP and ET were compared with the footprint of eddy covariance observations. The simulated daily GPP has a root mean square error (RMSE) of 1.56 $g \cdot C \cdot m^{-2} \cdot d^{-1}$ and a correlation coefficient of 0.87. The simulated daily ET has a RMSE of 14.41 $W \cdot m^{-2}$ and a correlation coefficient of 0.83. This study demonstrates the potential of UAS based multispectral and thermal mapping to continuously estimate GPP and ET for both sunny and cloudy weather conditions.

Reference:

Noilhan, J., & Planton, S. (1989). A simple parameterization of land surface processes for meteorological models. Monthly Weather Review, 117(3), 536-549.

Potter, C. S., Randerson, J. T., Field, C. B., Matson, P. A., Vitousek, P. M., Mooney, H. A., & Klooster, S. A. (1993). Terrestrial ecosystem production: a process model based on global satellite and surface data. Global Biogeochemical Cycles, 7(4), 811-841.

Fisher, J. B., Tu, K. P., & Baldocchi, D. D. (2008). Global estimates of the land–atmosphere water flux based on monthly AVHRR and ISLSCP-II data, validated at 16 FLUXNET sites. Remote Sensing of Environment, 112(3), 901-919.

García, M., et al. (2013). Actual evapotranspiration in drylands derived from in-situ and satellite data: Assessing biophysical constraints. Remote Sensing of Environment, 131, 103-118.